INTERNATIONAL STANDARD

ISO 16437

First edition
2012-07-01

Ships and marine technology — Lifesaving and fire protection — Atmospheric oil mist detectors for ships

Navires et technologie maritime — Sauvetage et protection contre le feu — Détecteurs de brouillard d'huile atmosphériques pour navires

Reference number
ISO 16437:2012(E)

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 16437 was prepared by Technical Committee ISO/TC 8, *Ships and marine technology*, Subcommittee SC 1, *Lifesaving and fire protection.*

Introduction

The majority of fires which have occurred in engine rooms are generally caused by a leak or fracture from a flammable liquid system. Most engine room fires begin as a result of the ignition of oil mist. The mist can be formed in one of two ways:

— when oil mist is generated through minute leaks in oil lines which, under pressure, give off a very fine atomized spray: and,

— when oil hits a hot surface and boils, generating a mist.

Detection at this stage could therefore provide a pre-alarm warning to the risk of fire.

Oil mist detection systems are available to continuously monitor the machinery space atmosphere. They can give early warning of a dangerous onset of oil mist accumulation and can be incorporated in arrangements to automatically shut down valves, machinery, etc., to prevent the outbreak of fire.

For this purpose, atmospheric oil mist detection systems should be installed where an identified risk of fire hazard exists from the potential generation of oil mist from flammable liquids such as hydraulic, fuel and lubricating oil systems. Oil mist detection systems are particularly useful in engine rooms, oil purifying rooms, and hydraulic pump rooms on board ships, as well as fixed and floating offshore hydrocarbon platforms.

This International Standard has been developed for oil mist detectors on board ships and specifies the requirements for detectors used to detect volatile mist that can result in a fire. It is based on the document *Guidelines for the manufacture and installation of oil mist detectors* prepared by the International Maritime Organization (IMO) sub-committee on fire protection (FP).

Ships and marine technology — Lifesaving and fire protection — Atmospheric oil mist detectors for ships

1 Scope

1.1 This International Standard specifies requirements, test methods and performance criteria for resettable oil mist detectors for use in fire hazard alarm systems installed on marine vessels. Oil mist detectors may be installed where an identified risk of fire caused by ignition of flammable liquids, such as hydraulic, fuel and lubricating oil systems, exists.

1.2 This International Standard specifies requirements for the following detectors:

— point type detectors employing a point aspirating sampling device or relying on dispersion of oil mist;

— aspirating detectors, whereby the sampling point is separated from the sensing unit(s) and uses a pipe network for carrying the sampling air to the sensing unit(s);

— open path or beam type detectors, whereby the concept of the point detector is expanded to a sampling path which can be 20 m or more, as opposed to a few centimetres in the point type detector.

1.3 For the testing of other types of detector working on different principles, this International Standard is only for guidance. Detectors with special characteristics and developed for specific risks, as well as those designed for use in explosive atmospheres, are not covered by this International Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 7240-2, *Fire detection and alarm systems — Part 2: Control and indicating equipment*

ISO 7240-4, *Fire detection and alarm systems — Part 4: Power supply equipment*

IEC 60068-1, *Environmental testing — Part 1: General and guidance*

IEC 60068-2-1, *Environmental testing — Part 2-1: Tests — Test A: Cold*

IEC 60068-2-2, *Environmental testing — Part 2-2: Tests — Test B: Dry heat*

IEC 60068-2-6, *Environmental testing — Part 2-6: Tests — Test Fc: Vibration (sinusoidal)*

IEC 60068-2-30, *Environmental testing — Part 2-30: Tests — Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4-4: Testing and measurement techniques — Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) — Part 4-5: Testing and measurement techniques — Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) — Part 4-6: Testing and measurement techniques — Immunity to conducted disturbances, induced by radio-frequency fields*

EN 50086-1:1994, *Specification for conduit systems for cable management — Part 1: General requirements*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
alarm set point(s)
oil mist density in the proximity of the specimen at the moment that it generates an alarm signal, when tested as specified in 5.1.6

3.2
aspirating detector
sampling device which consists of a pipe network and sampling point which is separated from the sensing unit(s)

NOTE Sampling air and aerosols are drawn through the sampling device, using the pipe network, and carried to one or more sensing elements by an integral aspirator (e.g. fan or pump). Each sensing element may contain more than one sensor exposed to the same air.

3.3
conditioning
exposure of a specimen to environmental conditions to determine the effect of such conditions on the specimen

3.4
fault indication
audible, visible or other type of output different from an alarm signal conveying, directly or indirectly, a warning or indication that the detector is not working satisfactorily

3.5
gravimetric deterministic method
process where the difference in weight of a 0,8 µm pore size membrane filter is ascertained from weighing the filter before and after drawing one litre of oil mist from the test chamber

3.6
lower explosive limit
volume concentration of oil mist, flammable gas or vapour in air, below which the mixture is not explosive

NOTE 1 Also referred to as the lower flammable limit (LFL).

NOTE 2 The lower explosive limit corresponds to an oil mist concentration of approximately 50 mg/l.

3.7
minimum flow rate
minimum flow rate claimed by the manufacturer as meeting the requirements of this International Standard

3.8
non-volatile memory
memory elements which do not require the presence of an energy source for the retention of their contents

3.9
point type detector
point sampling device, sensor type, which operates by aspirating or relying on dispersion of oil mist

3.10
recovery
treatment of a specimen, after conditioning, so that the properties of the specimen can be stabilized before measurement of the said property as required by this International Standard

3.11
repeatability
closeness of agreements between the results of successive measurements of the same value of the same quantity carried out by the same method, with the same measuring instruments, by the same observer, in the same laboratory within a quite short interval of time in unchanged conditions

3.12
sampling device
component or series of components or dedicated device (e.g. a pipe network, dedicated duct, probe or hood) which transfers samples of air to the oil mist sensing element(s)

3.13
sampling point
point at which an air sample is drawn into the sampling device

3.14
sensitivity adjustment
adjustment during or after commissioning which leads to a change in the response to oil mist density

3.15
site-specific detector data
alterable data required for the detector to operate in a defined detector configuration

3.16
transport time
time for aerosols to transfer from a sampling point to the oil mist sensing element

4 Requirements

4.1 General

4.1.1 The detector shall reliably measure the oil mist concentration under the stated application conditions, produce an alarm signal and, if applicable, shall be able to initiate external alarm and protective actions, whenever the level exceeds or falls below a pre-selected alarm concentration.

4.1.2 Detector parts shall be able to withstand the stresses due to vibration, dust, corrosive media and climatic influences during normal use.

4.1.3 Materials and components shall be used within the ratings or limits specified by the material or component manufacturer, unless otherwise specified by appropriate safety standards taking into account the limits of specific operating conditions.

4.1.4 Materials that come into contact with the oil mist shall not affect the measured value in milligrams per litre for the oil mist.

4.1.5 Detectors shall be constructed to

— facilitate easy access for regular function checks and calibration, and

— allow periodic maintenance of serviceable parts and cleaning of sensing surfaces.

4.1.6 The oil mist path of the detector, including any filter and sampling device, shall not be affected by gases expected to be present in the environment.

4.1.7 Any zero-point and gain adjustments shall be independent of each other.

4.1.8 Detectors with more than one measuring range shall clearly identify the selected range.

4.1.9 This International Standard is drafted on the basis of functions which are required to be provided on all oil mist detectors, and optional functions with requirements which may be provided. It is intended that the options will be used for specific applications, as recommended in application guidelines.

4.1.10 Each optional function is included as a separate entity with its own set of associated requirements in order to permit oil mist detectors on board ships with different combinations of functions to conform to this International Standard. If an option is taken, all the corresponding requirements shall be met.

4.1.11 Other functions associated with fire detection and fire alarm may also be provided, even if not specified in this International Standard. However, such options shall not contradict any requirements of this International Standard and must not, in case of a fault, jeopardize any function required by this International Standard.

4.2 Compliance

In order to comply with this International Standard, the detector shall meet the requirements of this clause, which shall be verified by visual inspection or engineering assessment, shall be tested as specified in Clause 5 and shall meet the requirements of the tests.

4.3 Detector calibration

Detectors should have at least two calibrated set points, one at the lowest detection point or zero concentration and the other at the highest detection point determined by the manufacturer, which must be at least 2,0 mg/l or 4 % of the lower explosive limit (LEL). For this reason the measuring system should indicate up to at least 4 % of LEL.

4.4 Cleaning alarm

Detectors must be able to indicate that sensors need cleaning to stop false alarms.

4.5 Indicating devices

An indication shall be provided to show that the detector is switched on. For alarm-only detectors, the manufacturer shall identify suitable points for connecting indicating or recording devices for the purpose of testing. If the apparatus has more than one measuring range, the range selected shall be clearly identified.

4.6 Individual detector indicators

4.6.1 The monitors or individual detector indicators should indicate a maximum reading, e.g. 2,0 mg/l or 4 % of the LEL.

4.6.2 Each detector shall be provided with an integral visual indicator or indicators, by which the individual detector which created an alarm can be identified until the alarm condition is reset. Where other conditions of the detector can be visually indicated, these shall be clearly distinguishable from the alarm indication, except when the detector is switched into a service mode. For detachable detectors, the indicator may be integral with the base or the detector head.

4.6.3 Each detector shall be provided with a fault indication in the event of

— failure of power to the detector,

— loss of continuity or short circuit in one or more of the wires to the detector,

— loss of electrical continuity within the detector, or

— need for cleaning of the sensor.

4.6.4 Where other conditions of the status of the detector are indicated visually, the following colours shall be used:

— red, for indication of a percentage of a potentially high oil mist level;

— green, for power supply normal.

4.6.5 Each indicator shall be labelled to show its function.

4.7 Connection of ancillary devices

The detector may provide for connections to ancillary devices (remote indicators, control relays, etc.), but open- or short-circuit failures of these connections shall not prevent the correct operation of the detector.

4.8 Monitoring of detachable detectors

For detachable detectors, a means shall be provided for a remote monitoring system (e.g. the control and indicating equipment) to detect the removal of the head from the base, in order to give a fault signal.

4.9 Manufacturer’s adjustments

It shall not be possible to change the manufacturer’s settings except by special means, e.g. with the use of a special code or tool, or by breaking or removing a seal.

4.10 On-site adjustment of response behaviour

4.10.1 If there is provision for on-site adjustment of the response behaviour of the detector, then:

a) for all of the settings at which the manufacturer claims compliance with this International Standard, the detector shall comply with the requirements of this International Standard and access to the adjustment means shall only be possible by the use of a code or special tool or by removing the detector from its base or mounting;

b) any setting(s) at which the manufacturer does not claim compliance with this International Standard shall only be accessible by the use of a code or special tool, and it shall be clearly marked on the detector or in the associated data that if these setting(s) are used, the detector does not comply with this International Standard.

4.10.2 These adjustments may be carried out at the detector or at the control and indicating equipment.

4.11 Response to slow increases of oil mist concentrations

4.11.1 Compensation may be used to mitigate changes in sensitivity due to the build-up of dust and other contaminants on the sensing surfaces.

4.11.2 The provision of drift compensation and/or the provision of algorithms to match a detector to its environment shall not lead to a significant reduction in the sensitivity of the detector to slow increases in the concentration levels of oil mist.

4.11.3 The detector shall cause either a fault or alarm signal at the limit of compensation for the effect of a slowly changing signal response.

4.11.4 Since it is not practical to make tests with very slow increases in the concentration levels of oil mist, an assessment of the response of the detector to slow increases in the concentration levels of oil mist shall be made by analysis of the circuit/software, and/or physical tests and simulations. Where such algorithms are used, the detector shall be deemed to meet the requirements of this clause if the documentation and assessment shows:

a) how and why a sensor drifts;

b) how the compensation technique modifies the detector response to compensate for the drift;

c) that suitable limits to the compensation are in place to prevent the algorithms/means being applied outside the known limitations of the sensor and to ensure ongoing compliance with the clauses of this International Standard;

d) for any rate of increase in oil mist concentration, R, which is greater than $A/4$ per hour (where A is the detector's initial uncompensated alarm set point), the time for the detector to give an alarm does not exceed 1,6 A/R by more than 100 s;

e) the range of compensation is limited such that, throughout this range, the compensation does not cause the alarm set point of the detector to exceed its initial value by a factor greater than 1,6.

4.12 Marking

4.12.1 Each detector shall be clearly marked with the following information:

a) the number of this International Standard (i.e. ISO 16437);

b) the name or trademark of the manufacturer or supplier;

c) some mark(s) or code(s) (e.g. serial number or batch code), by which the manufacturer can identify, at least, the model designation (type or number), the date or batch and place of manufacture, and the version number(s) of any software contained within the detector.

4.12.2 Where any marking on the device uses symbols or abbreviations not in common use, these should be explained in the data supplied with the device.

4.12.3 The markings shall be visible after installation of the detector.

4.12.4 The markings shall not be placed on screws or other easily removable parts.

4.13 Instruction manual

Each detector shall be accompanied by an instruction manual. It shall include the following information:

1) intended use;
2) operational limitations (e.g. ambient temperature, humidity, pressure, flow rate, supply voltage);
3) tests and certificates;
4) measuring principles;
5) indication of alarms;
6) mechanical structure and diagram of apparatus;
7) description of apparatus function;
8) technical data;
9) start-up procedure;
10) calibration and adjustment procedure;
11) service and maintenance;
12) measure to be taken in case of malfunctions;
13) accessories and replacement parts.

4.14 Data

4.14.1 Detectors shall be supplied with sufficient technical, installation and maintenance data to enable their correct installation and operation. To enable correct operation of the detectors, this data should describe the requirements for the correct processing of the signals from the detector. This may be in the form of a full technical specification of these signals, a reference to the appropriate signalling protocol or a reference to suitable types of control and indicating equipment.

4.14.2 Installation and maintenance data shall include reference to an *in situ* test method to ensure that detectors operate correctly when installed.

NOTE Additional information may be required by organizations certifying that detectors produced by a manufacturer conform to the requirements of this International Standard.

4.15 Requirements for software-controlled detectors

4.15.1 General

The requirements of 4.15.2, 4.15.3 and 4.15.4 shall be met for detectors which rely on software control in order to fulfil the requirements of this International Standard.

4.15.2 Software documentation

4.15.2.1 The manufacturer shall have documentation available for inspection which gives an overview of the software design, and provide it to the testing authority if required. This documentation shall be in sufficient detail for the design to be inspected for compliance with this International Standard and shall include at least the following:

a) a functional description of the main program flow (e.g. as a flow diagram or structogram) including:

   1) a brief description of the modules and the functions that they perform,

   2) the way in which the modules interact,

   3) the overall hierarchy of the program,

   4) the way in which the software interacts with the hardware of the detector,

   5) the way in which the modules are called, including any interrupt processing;

b) a description of which areas of memory are used for the various purposes (e.g. the program, site-specific data and running data);

c) a designation, by which the software and its version can be uniquely identified.

4.15.2.2 The manufacturer shall have available detailed design documentation, which only needs to be provided if required by the testing authority. It shall comprise at least the following:

a) an overview of the whole system configuration, including all software and hardware components;

b) a description of each module of the program, containing at least:

   1) the name of the module,

   2) a description of the tasks performed,

   3) a description of the interfaces, including the type of data transfer, the valid data range and the checking for valid data;

c) full source code listings, as hard copy or in machine-readable form (e.g. ASCII-code), including all global and local variables, constants and labels used, and sufficient comment for the program flow to be recognized;

d) details of any software tools used in the design and implementation phase (e.g. CASE-Tools, Compilers, etc.).

4.15.3 Software design

In order to ensure the reliability of the detector, the following requirements for software design apply.

a) The software shall have a modular structure.

b) The design of the interfaces for manually and automatically generated data shall not permit invalid data to cause error in the program operation.

c) The software shall be designed to avoid the occurrence of deadlock of the program flow.

4.15.4 The storage of programs and data

4.15.4.1 The program necessary to comply with this International Standard and any preset data, such as manufacturer's settings, shall be held in non-volatile memory. Writing to areas of memory containing this program and data shall only be possible by the use of some special tool or code, and shall not be possible during normal operation of the detector.

4.15.4.2 Site-specific data shall be held in memory which will retain data for at least two weeks without external power to the detector, unless provision is made for the automatic renewal of such data, following loss of power, within 1 h of power being restored.

4.16 Monitoring of memory contents — optional function

Means may be provided for detecting the loss of site-specific data. If such a loss occurs, a signal shall be made available to the control and indicating equipment within a time limit specified by the manufacturer.

4.17 Additional requirements for aspirating detectors

4.17.1 General

Where the detector includes an aspirating device, the additional requirements of 4.17 apply.

4.17.2 Mechanical strength of the pipework

4.17.2.1 The sampling pipes and fittings shall have adequate mechanical strength and temperature resistance.

4.17.2.2 The minimum requirement shall be pipes classified in accordance with EN 50086-1 to at least Class 1131 (for the definition of "1131" see Table 1).

Table 1 — Mechanical requirements for sampling pipes

Property	Class	Severity
Resistance to compression	1	125 N
Resistance to impact	1	0,5 kg, 100 mm height to fall
Temperature range	31	−15 °C to +60 °C

4.17.2.3 Pipes which are not so classified by the manufacturer of the pipe shall either be tested in accordance with the tests in Table 2 for the above classes or the manufacturer shall provide evidence that the requirements of this clause are met.

Table 2 — Mechanical tests

Test	EN 50086-1 Clause
Compression test	10.2
Impact test[a]	10.3
Resistance to heat[b]	12.2

[a] Conduct the impact test at the minimum of the temperature range (i.e. –15 °C).

[b] The pipe is deemed to have passed the resistance to heat test if any crushing of the pipe does not reduce the internal diameter to less than 80 % of its original value.

4.17.2.4 Where the manufacturer of the aspirating detector does not supply the pipe for the sampling device, the product documentation shall specify that the requirements of this clause shall be met.

4.17.3 Hardware components and additional sensing elements in the sampling device

4.17.3.1 Components, including optional components (box, filter, sensor, valve, etc.) in the sampling device shall be described in the documentation. The aspirating detector, including the hardware components listed, shall meet the requirements of this International Standard.

4.17.3.2 If the component incorporates a sensing element which participates in the signal output of the aspirating detector (e.g. for localization information) then the performance of the aspirating detector, including these sensing elements, shall meet the requirements of this International Standard.

4.17.4 Alarm outputs providing localization information

When the aspirating detector is designed to provide several alarm outputs within a single zone, where each output relates to a subdivision within the area protected by the aspirating detector, then it shall be clearly indicated in the product documentation that the several alarm outputs are reported as alarm information within one zone at the control and indicating equipment.

4.17.5 Airflow monitoring

4.17.5.1 The airflow through the aspirating oil mist detector shall be monitored to detect leakage or obstruction of the sampling device or sampling point(s). A fault shall be indicated when the leakage or obstruction results in an increase or decrease in the volumetric airflow of 20 % or greater.

4.17.5.2 Where the aspirating detector incorporates technology which provides for constant, or near constant, volumetric flow rate which is largely independent of the sampling device (e.g. incorporates speed control of the fan or uses a positive displacement pump), then equivalent requirements for the flow monitoring device shall be agreed between the manufacturer and testing authority to verify the flow monitoring to detect loss of sampling points (caused by blockage or breakage in the sampling device).

4.17.5.3 Where an aspirating detector has a facility to memorize the “normal” flow (present when the detector is installed or serviced) and thereafter monitor for deviations from this normal flow, the action of setting the memorized “normal” flow shall be a voluntary action under access level 3 (as defined in ISO 7240-2).

4.17.5.4 Electrical power supply failure to the aspirating detector shall not result in a change to the memorized normal flow.

4.17.6 Power supplies

The power for the aspirating detector shall be supplied by a power supply conforming to ISO 7240-4.

5 Test methods

5.1 General

5.1.1 Atmospheric conditions for tests

5.1.1.1 Unless otherwise stated in a test procedure, the testing shall be carried out after the test specimen has been allowed to stabilize in the standard atmospheric conditions for testing, as specified in IEC 60068-1 as follows:

Temperature: (15 to 45) °C

Relative humidity: (30 to 90) %

Air pressure: (86 to 106) kPa

5.1.1.2 The temperature and humidity shall be substantially constant for each environmental test where the standard atmospheric conditions are applied.

5.1.2 Operating conditions for tests

5.1.2.1 If a test method requires a specimen to be operational, then the specimen shall be connected to suitable supply and monitoring equipment with characteristics as required by the manufacturer's data. Unless otherwise specified in the test method, the supply parameters applied to the specimen shall be set within the manufacturer's specified range(s) and shall remain substantially constant throughout the tests. The value chosen for each parameter shall normally be the nominal value, or the mean of the specified range. If a test procedure requires a specimen to be monitored to detect any alarm or fault signals, then connections shall be made to any necessary ancillary devices (e.g. through wiring to an end-of-line device) to allow a fault signal to be recognized.

5.1.2.2 The details of the supply and monitoring equipment and the alarm criteria used shall be given in the test report (Clause 7).

5.1.3 Mounting arrangements

The specimen shall be mounted by its normal means of attachment in accordance with the manufacturer's instructions. If these instructions describe more than one method of mounting, then the method considered to be most unfavourable shall be chosen for each test.

5.1.4 Tolerances

5.1.4.1 Unless otherwise stated, the tolerances for the environmental test parameters shall be as given in the basic reference standards for the test (e.g. the relevant part of IEC 60068).

5.1.4.2 If a specific tolerance or deviation limit is not specified in a requirement or test procedure, then a deviation limit of ± 5 % shall be applied.

5.1.5 Test classification

5.1.5.1 General

The purpose of the environmental tests is to demonstrate that a detector can operate correctly in its service environment and that it will continue to do so for a reasonable time. The tests are intended to demonstrate failures due to realistic service environments; however, some significant failure mechanisms are brought about by changes which occur slowly under these realistic service conditions. In order to make tests within a practical and economic time-scale, it is sometimes necessary to accelerate these changes by intensifying the conditions (e.g. by increasing the level of an environmental parameter or by increasing the frequency of its application). The tests are divided into two classes.

5.1.5.2 Operational tests

5.1.5.2.1 The test specimen is subjected to test conditions which correspond to the service environment. The object of these tests is to demonstrate the ability of the equipment to withstand and operate correctly in the normal service environment and/or to demonstrate the immunity of the equipment to certain aspects of that environment.

5.1.5.2.2 The specimen is therefore operational, its condition is monitored and it may be functionally tested during the tests.

5.1.5.3 Endurance tests

The test specimen may be subjected to conditions more severe than the normal service environment in order to accelerate the effects of the normal service environment. The object of these tests is to demonstrate the ability of the equipment to withstand the long-term effects of the service environment. Since the tests are intended to study the residual rather than the immediate effects, the specimens are normally not supplied with power or monitored during the conditioning period. However, if by reason of the design of the specimen it is necessary for a power supply to be connected, any signal generated during the test shall be ignored.

5.1.6 Measurement of alarm set point

5.1.6.1 Typical measurement procedure

5.1.6.1.1 Install the sampling device in the oil mist test chamber, specified in Annex A or Annex B, in its normal operating position, by its normal means of attachment.

5.1.6.1.2 Before commencing each measurement, purge the oil mist chamber with clean air to ensure that the chamber and the specimen are free from the oil mist.

5.1.6.1.3 Unless otherwise specified in the test procedure, the air temperature in the oil mist chamber shall be 23 °C and shall not vary by more than 5 °C for all the measurements on a particular detector type.

5.1.6.1.4 Connect the specimen to its supply and monitoring equipment as specified in 5.1.2, and allow it to stabilize for a period of at least 15 min, unless otherwise specified by the manufacturer.

5.1.6.1.5 Maintain the minimum airflow through the detector as specified by the manufacturer.

5.1.6.1.6 Perform the oil mist test specified in Annex A. An alternative test method to Annex A can be found in Annex B. An example of an oil mist generator is illustrated in Annex C.

5.1.6.1.7 Measure the aerosol density in the proximity of the specimen.

5.1.6.1.8 The alarm set point M shall be not less than 4 % of the lower explosive limit or 2,0 mg/l.

NOTE The lower explosive limit corresponds to an oil mist concentration of approximately 50 mg/l (13 % oil–air mixture).

5.1.6.2 General for aspirating detectors

Since there are a number of different types of aspirating detectors available operating on quite different principles, which have very different ranges of sensitivity, various methods can be used to establish the alarm set point. The object of any method chosen shall be to determine a measure of the aerosol concentration which, when passing through the detector, just causes an alarm to be raised. This can generally be achieved by introducing oil mist into the test chamber so that the detector is subjected to a slowly increasing concentration, and recording the concentration at the moment when an alarm is generated.

5.1.6.3 Flow rate for aspirating detectors

The flow rate of oil mist through the detector shall conform to specifications of the manufacturer.

5.1.7 Provision for tests

For testing compliance with this International Standard, the following apply:

a) The data required in 4.14 shall be provided.

b) The specimens submitted shall be deemed representative of the manufacturer's normal production with regard to their construction and calibration

NOTE Detachable detectors comprise at least two parts; for example a base (socket) and a head (body). If the specimens are detachable detectors, then the two, or more, parts together are regarded as a complete detector.

5.1.8 Test schedule

The specimens shall be tested in accordance with Table 3.

5.1.9 Test report

The test results shall be reported in accordance with Clause 7.

Table 3 — Test schedule

Test	Subclause
Repeatability	5.2
Dry heat (operational)	5.3
Cold (operational)	5.4
Damp heat	5.5
Vibration, sinusoidal (operational)	5.6
High voltage	5.7
Variation of supply parameters	5.8
Electrical power supply failure	5.9
Insulation resistance[a]	5.10
Electrostatic discharge immunity	5.11
Radiated radio frequency immunity	5.12
Conducted low frequency immunity	5.13
Conducted high frequency immunity	5.14
Burst/fast response transient immunity	5.15
Surge immunity	5.16
Additional tests for aspirating detectors	5.17
Air leakage	5.17.2
Airflow fault (operational)	5.17.3
Airflow monitoring facility	5.17.4

[a] Measurements shall be performed before and after the relevant environmental tests.

5.2 Repeatability

5.2.1 Object

To show that the detector has stable behaviour with respect to its sensitivity even after a number of alarm conditions.

5.2.2 Test procedure

5.2.2.1 The readings from the specimen to be tested shall be measured six times as described in 5.1.6.

5.2.2.2 The maximum and minimum of these six readings shall be designated M_{max} and M_{min}, respectively.

5.2.2.3 The orientation of the specimen relative to the direction of airflow is arbitrary, but it shall be the same for all six measurements.

5.2.3 Requirements

The ratio of the readings $M_{max} : M_{min}$ shall be not greater than 1,26.

5.3 Dry heat (operational)

5.3.1 Object of test

To demonstrate the ability of the specimen to function correctly at high ambient temperatures appropriate to the anticipated service environment.

5.3.2 Test procedure and apparatus

5.3.2.1 General

Use the test apparatus and perform the procedure as specified in IEC 60068-2-2, Test Bb and 6.2.2.2 to 6.2.3.4.

5.3.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.3.2.3 Conditioning

Apply the following conditioning.

Temperature: Starting at an initial air temperature of (23 ± 5) °C, increase the air temperature to (70 ± 2) °C.

Duration: Maintain the temperature for 2 h.

NOTE Test Bb specifies rates of change of temperature of ≤ 1 °C/min for the transitions to and from the conditioning temperature.

5.3.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

5.3.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.3.3 Requirements

No alarm or fault signals shall be given during the transition to the conditioning temperature or during the conditioning.

The specimen shall give an alarm signal in response to the reduced function test.

The ratio point values M_{max} : M_{min} shall be not greater than 1,26.

5.4 Cold (operational)

5.4.1 Object of test

To demonstrate the ability of the specimen to function correctly at low ambient temperatures appropriate to the anticipated service temperature.

5.4.2 Test procedure

5.4.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-1, Test Ab and 6.3.2.2 to 6.3.2.4.

5.4.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.4.2.3 Conditioning

5.4.2.3.1 Apply the following conditioning.

Temperature: (5 ± 3) °C

Duration: 2 h

5.4.2.3.2 For detectors intended for installation on open decks or exposure to the outside weather, apply the following conditioning.

Temperature: (–25 ± 3) °C

Duration: 2 h

NOTE Test Ab specifies rates of change of temperature of ≤ 1 °C/min for the transitions to and from the conditioning temperature.

5.4.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals. During the last 30 min of the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

5.4.2.5 Final measurements

5.4.2.5.1 After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6.

5.4.2.5.2 Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.4.3 Requirements

5.4.3.1 No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

5.4.3.2 The specimen shall give an alarm signal in response to the reduced functional test.

5.4.3.3 The ratio $M_{max} : M_{min}$ shall be not greater than 1,26.

5.5 Damp heat

5.5.1 Object of test

To demonstrate the ability of the specimen to function in an environment with high relative humidity where condensation can occur on the equipment.

5.5.2 Test procedure

5.5.2.1 Reference

Use the test apparatus and procedures as specified in IEC 60068-2-30, Test Db and 6.4.2.2 to 6.4.2.4.

5.5.2.2 State of the specimen during conditioning

5.5.2.2.1 Mount the specimen as specified in 5.1.3.

5.5.2.2.2 The test duration shall be 24 h in accordance with IEC 60068-2-30, Test Db.

5.5.2.2.3 During the first 12 h of the conditioning, connect the specimen to supply and monitoring equipment as specified in 5.1.2.

5.5.2.2.4 During the second 12 h of conditioning, do not supply the specimen with power.

NOTE Any self-test feature intended to monitor the transmission of the detector window may be disabled during this test.

5.5.2.3 Conditioning

The following severity of conditioning shall be applied:

Temperature: (55 ± 2) °C

Relative humidity: (95 ± 5) %

Duration: 24 h

5.5.2.4 Measurements during conditioning

5.5.2.4.1 Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.5.2.4.2 During the first 2 h of conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

5.5.2.4.3 During the last 2 h of conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

5.5.2.5 Final measurements

After the recovery period of at least 1 h at standard atmospheric conditions, measure the response point of the specimen in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.5.3 Requirements

No alarm or fault signals shall be given during the transition to or the period at the conditioning temperature.

The specimen shall give an alarm signal in response to the reduced functional test.

The ratio M_{max} : M_{min} shall be not greater than 1,26.

5.6 Vibration, sinusoidal (operational)

5.6.1 Object of test

To demonstrate the immunity of the specimen to vibration at levels considered appropriate to the normal marine service environment.

5.6.2 Test procedure

5.6.2.1 Reference

Use the test apparatus and perform the procedure as specified in IEC 60068-2-6, Test Fc and 6.4.2.2 to 6.4.2.5.

5.6.2.2 State of the specimen during conditioning

Mount the specimen on a rigid fixture as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2. Apply the vibration in each of three mutually perpendicular axes in turn, and so that one of the three axes is perpendicular to the normal mounting plane of the specimen.

5.6.2.3 Conditioning

Apply the conditioning specified in Table 4.

Table 4 — Vibration test

Frequency	Amplitude	Acceleration
(+3/−0) Hz – 13,2 Hz	± 1,0 mm	–
13,2 Hz – 100 Hz	–	± 0,7g

If resonance points do not exist, apply the vibration of acceleration ± 0,7g at 30 Hz for 90 min.

Where resonance points are found, either repeat the test with necessary provisions to avoid resonance or apply the vibration, using the same amplitude or acceleration of resonance point, at the resonance frequency for 90 min.

For equipment intended for installation in severe vibration conditions, such as diesel engines or air compressors, the vibration level specified in Table 5 shall be applied.

Table 5 — Severe vibration test

Frequency	Amplitude	Acceleration
(+3/−0) Hz – 25 Hz	± 1,6 mm	–
25 Hz – 100 Hz	–	± 4,0g

5.6.2.4 Measurements during conditioning

Monitor the specimen during the conditioning period to detect any alarm or fault signals.

5.6.2.5 Final measurements

After the conditioning, visually inspect the specimen for mechanical damage both internally and externally.

Measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.6.3 Requirements

No alarm or fault signals shall be given during the conditioning. No mechanical damage either internally nor externally shall result.

The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.7 High voltage

5.7.1 Object of test

To demonstrate the immunity of the specimen to high voltage surges that can occur in a marine service environment.

5.7.2 Test procedure

5.7.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.7.2.2 Conditioning

Apply alternating current voltages specified in Table 6 at a frequency of 50 Hz or 60 Hz between current carrying parts and earth for 1 min.

Table 6 — Test voltages

Rated voltage, V_r V	Test voltage V
$V_r \le 65$	$2V_r + 500$
$65 < V_r \le 250$	1 500
$250 < V_r \le 500$	2 000
$500 < V_r \le 690$	2 500

For equipment containing circuits in which electronic apparatus is used and the application of the test voltage is not desirable, the circuits may be removed before applying the test voltages.

5.7.2.3 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.7.3 Requirements

No alarm or fault signals shall be given during the conditioning.

The ratio of the response points M_{max} : M_{min} shall not be greater than 1,26.

5.8 Variation of supply parameters

5.8.1 Object of test

To show that, within the specified range(s) of the supply parameters (e.g. voltage), the response point of the specimen is not unduly dependent on those parameters.

5.8.2 Test procedure

5.8.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.8.2.2 Conditioning

Apply the supply parameter variations as specified in Table 7.

Table 7 — Electrical supply variation parameters

<table>
<tr><th rowspan="2">Parameter</th><th colspan="2">Variation from rated value
%</th></tr>
<tr><th>Voltage</th><th>Frequency</th></tr>
<tr><td>Permanent AC</td><td></td><td></td></tr>
<tr><td>Combination 1</td><td>+6</td><td>+5</td></tr>
<tr><td>Combination 2</td><td>+6</td><td>−5</td></tr>
<tr><td>Combination 3</td><td>−10</td><td>+5</td></tr>
<tr><td>Combination 4</td><td>−10</td><td>−5</td></tr>
<tr><td>Temporary AC</td><td></td><td></td></tr>
<tr><td>Combination 5</td><td>+20 for 1,5 s</td><td>+10 for 5 s</td></tr>
<tr><td>Combination 6</td><td>−20 for 1,5 s</td><td>−10 for 5 s</td></tr>
<tr><td>DC</td><td></td><td></td></tr>
<tr><td>For equipment not related to a battery</td><td>Tolerance (continuous) ± 10
Cyclic variation 5
Ripple 10</td><td></td></tr>
<tr><td>For equipment related to a battery</td><td>−25, +30 for equipment connected to a battery during charging
−25, +20 for equipment not connected to a battery during charging</td><td></td></tr>
</table>

5.8.2.3 Measurements during conditioning

Measure the alarm set point in accordance with 5.1.6 as appropriate, at the limits specified in Table 7.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

In the case of tests “Combination 5” and “Combination 6”, measurement of the response point may be omitted.

5.8.3 Requirements

No alarm or fault signals shall be given during the conditioning.

The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.9 Electrical power supply failure

5.9.1 Object of test

To demonstrate the ability of the specimen to operate normally following an interruption to the power supply.

5.9.2 Test procedure

5.9.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to supply and monitoring equipment as specified in 5.1.2.

5.9.2.2 Conditioning

Disconnect the power supply to the specimen for a period of 30 s three times over 5 min.

5.9.2.3 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.9.3 Requirements

No abnormality shall be observed after the power supply equipment is reconnected to the specimen. The equipment shall operate satisfactorily. The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.10 Insulation resistance

5.10.1 Object of test

To demonstrate the integrity of the electrical insulation of the specimen.

5.10.2 Test procedure

5.10.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 but do not supply it with power during conditioning.

5.10.2.2 Conditioning

Apply the voltages specified in Table 8 to current carrying parts and between current parts and earth.

Table 8 — Test voltages

Rated voltage, V_r V	**Test voltage** V
$V_r \leq 65$	$2V_r$ and not less than 24
$V_r > 65$	500

For the equipment containing circuits in which electronic apparatus are used and the application of the test voltage is not desirable, apply the test voltage after removing the circuits.

5.10.2.3 Final measurements

Measure the insulation resistance between current carrying parts and between current parts and earth.

5.10.3 Requirements

The insulation resistance shall be not less than the value specified in Table 9.

Table 9 — Insulation resistance

Rated voltage, V_r V	**Insulation before environmental test** MΩ	**Insulation after environmental test** MΩ
$V_r \leq 65$	10	1
$V_r > 65$	100	10

5.11 Electrostatic discharge immunity

5.11.1 Object of test

To demonstrate the immunity of the specimen to the effects of electrostatic discharge.

5.11.2 Test procedure

5.11.2.1 Reference

Perform the procedure as specified in Level 3 of IEC 61000-4-2.

5.11.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.11.2.3 Conditioning

The test conditions should be confined to the points and surfaces that can normally be reached by the operator.

Contact discharge: 6 kV

Air discharge: 8 kV

Interval between single discharges: 1 s

Number of pulses: 10/polarity

5.11.2.4 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.11.3 Requirements

No alarm or fault signals shall be given during the conditioning. Degradation, loss of function or performanc, which is self-recoverable is permissible, but no actual change in operating state or stored data shall occur.

The ratio of the response points M_{max} : M_{min} shall not be greater than 1,26.

5.12 Radiated radio frequency immunity

5.12.1 Object of test

To demonstrate the immunity of the specimen to radio frequency interference.

5.12.2 Test procedure

5.12.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.12.2.2 Conditioning

Apply the following conditioning.

Frequency range:	80 MHz – 2 GHz
Modulation:	80 % AM at 1 kHz
Field strength:	10 V/m
Frequency sweep rate:	≤ 1,5 × 10^{-3} decades per second (or 1 %/3 s)

5.12.2.3 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.12.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points M_{max} : M_{min} shall not be greater than 1,26.

5.13 Conducted low frequency immunity

5.13.1 Object of test

To demonstrate the immunity of the specimen to low frequency interference.

5.13.2 Test procedure

5.13.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.13.2.2 Conditioning

Apply the conditioning specified in Table 10.

Table 10 — Low frequency immunity parameters

Test voltage	Frequency[a]	Frequency[b]
10 % of AC supply voltage	60 Hz – 900 Hz	50 Hz – 750 Hz
10 % of AC supply voltage	900 Hz – 6 kHz	750 Hz – 5 kHz
1 % of AC supply voltage	6 kHz – 12 kHz	5 kHz – 10 kHz
10 % of DC supply voltage and at least 3 V	50 Hz – 10 kHz	50 Hz – 10 kHz
Maximum power	2 W	2 W

[a] Where rated frequency of the equipment is 60 Hz.

[b] Where rated frequency of the equipment is 50 Hz.

5.13.2.3 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.13.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.14 Conducted high frequency immunity

5.14.1 Object of test

To demonstrate the immunity of the specimen to high frequency interference.

5.14.2 Test procedure

5.14.2.1 Reference

Perform the procedure as specified in Level 2 of IEC 61000-4-6.

5.14.2.2 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.14.2.3 Conditioning

Apply the following conditioning.

Frequency range:	150 kHz – 80 MHz
Modulation:	80 % AM at 1 kHz
Amplitude:	3 V r.m.s.

5.14.2.4 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.14.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.15 Burst/fast transient immunity

5.15.1 Object of test

To demonstrate the immunity of the specimen to fast bursts of electrical interference.

5.15.2 Test procedure

5.15.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.15.2.2 Reference

Perform the procedure as specified in Level 3 of IEC 61000-4-4.

5.15.2.3 Conditioning

Apply the following conditioning.

Single pulse time:	5 ns (between 10 % and 90 % value)
Single pulse width:	50 ns (50 % value)
Amplitude for line on power supply port and earth:	2 kV
Amplitude for line on I/O data control and signal lines:	1 kV
Pulse period:	300 ms
Burst duration:	15 ms
Duration:	5 min/polarity

5.15.2.4 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.15.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points $M_{max} : M_{min}$ shall not be greater than 1,26.

5.16 Surge immunity test

5.16.1 Object of test

To demonstrate the immunity of the specimen to electrical surges.

5.16.2 Test procedure

5.16.2.1 State of the specimen during conditioning

Mount the specimen as specified in 5.1.3 and connect it to its supply and monitoring equipment as specified in 5.1.2.

5.16.2.2 Reference

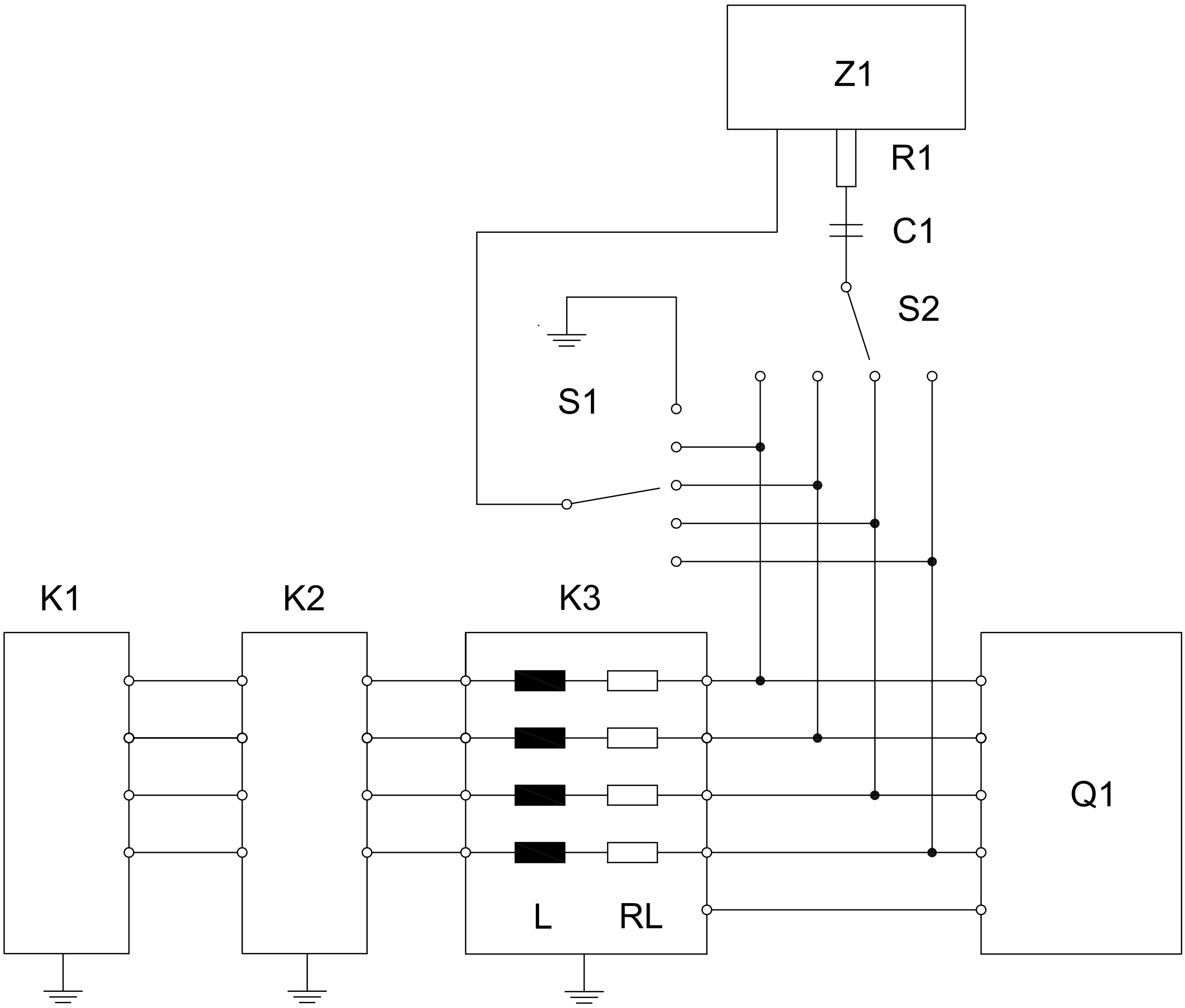
Perform the procedure as specified in Level 2 of IEC 61000-4-5.

5.16.2.3 Conditioning

Apply the following conditioning.

Pulse rise time:	1,2 µs (between 10 % and 90 % value)
Single pulse width:	50 µs (50 % value)
Amplitude between line and earth:	1 kV
Amplitude between lines:	0,5 kV
Repetition rate:	≥ 1 pulse/min
Number of pulses:	5/polarity

Where the power and signal lines are identical, the test procedure shall be in accordance with Figure 1. During the test, switch S1 to test positions 1–4, but not in the same position as S2. Also, switch S2 to test positions 1–4, but not in the same position as S1.



Key

Z1	combination wave generator	R1	resistor, $R = 40\ \Omega$
C1	capacitor, $C = 0{,}5\ \mu F$	S2	switch
S1	switch: line to earth – position 0 line to line – positions 1 to 4	K1	auxiliary equipment
K2	protection equipment	K3	decoupling network
L	inductor, $L = 20$ mH	RL	resistive part of inductor L
Q1	equipment under test		

Figure 1 — Example of a surge immunity test circuit

5.16.2.4 Final measurements

After the conditioning, measure the alarm set point in accordance with 5.1.6 as appropriate.

Designate the greater of the response points measured in this test and that measured for the same specimen in the repeatability test as M_{max}, and the lesser as M_{min}.

5.16.3 Requirements

No alarm or fault signals shall be given during the conditioning. No degradation, loss of function or performance as defined in the manufacturer's technical specification shall occur.

The ratio of the response points M_{max} : M_{min} shall not be greater than 1,26.

5.17 Additional tests for aspirating detectors

5.17.1 General

Aspirating detectors shall be tested in accordance with the additional tests of 5.17.

5.17.2 Air leakage

5.17.2.1 Object

To demonstrate the ability of a detector that uses aspirating techniques to remain sealed and thereby ensure minimum leakage to or from the sampled environment.

5.17.2.2 Test procedure

Mount the specimen as specified in 5.1.3 to a rigid fixture.

Seal the openings in the sampling pipe(s) so they are airtight (the sampling pipes may consist of separate inlet and outlet sampling pipes or of a combined inlet/outlet sampling pipe design).

Make provision in either the inlet or outlet sampling pipe for connection to a pressure/vacuum source.

Evacuate the specimen to a differential pressure of –1,13 kPa for 10 min.

Pressurize the specimen to +3,0 kPa for 10 min.

5.17.2.3 Requirements

The air leakage for the specimen shall be not more than that amount in Table 11.

Table 11 — Maximum leakage

Differential pressure after 10 min	
–1,13 kPa initial vacuum	+3,0 kPa initial pressure
≤ –0,75 kPa	≥ 2,0 kPa

5.17.3 Airflow fault (operational)

5.17.3.1 Object

To demonstrate the ability of a detector that uses a fan or pump, to report a fault.

5.17.3.2 Test procedure

Vary the flow rate from 130 % of the normal value or, if this is not possible, from the nominal value, down to the minimum flow rate –50 %. If a manufacturer indicates a smaller range for the detector, this information shall be confirmed by tests and then used to check the influence of the flow rate.

5.17.3.3 Requirements

A flow failure fault signal shall occur after the flow rate is reduced to less than the minimum flow rate.

5.17.4 Airflow monitoring facility

When testing of the airflow monitoring facility is required in test procedures, the detection of both increased and decreased airflow shall be verified.

Determine the normal volumetric airflow (F_n, e.g. litres per minute) from the sampling configuration used for the oil mist tests using suitable instrumentation.

The aspirating detector shall be set for a test flow rate ($F_t = F_n \pm 10$ %) for testing the airflow monitoring. For detectors that have a memorized normal flow, enter F_t into the memory in accordance with the normal operating instructions.

For decreased flow, the volumetric airflow is decreased from F_t by 20 % ($F_t - 20$ %).

For increased flow, the volumetric airflow is increased from F_t by 20 % ($F_t + 20$ %).

6 Installation

Some examples of installation are illustrated in Annex D.

7 Test report

The test report shall contain at a minimum the following information:

a) identification of the alarm tested;

b) reference to this International Standard;

c) results of the test: the individual alarm set points and the minimum, maximum, and arithmetic mean values where appropriate;

d) conditioning period and the conditioning atmosphere;

e) temperature and the relative humidity in the test room throughout the test;

f) details of the supply and monitoring equipment and the alarm criteria;

g) details of any deviation from this International Standard or from the International Standards to which reference is made, and details of any operations regarded as optional.

Annex A
(normative)

Calibration for master detector and/or functional test for product detector

A.1 Scope

This annex specifies test procedures and test apparatus for calibrating the master detector. This procedure is also applicable to the functional test of the oil mist detector. For open path detectors, the oil mist cloud intersecting the path of the detector shall be less than 200 mm to trigger the 4 % LEL alarm or approximately 2,0 mg/l.

NOTE This test procedure is based on IACS UR M67 [2], and modified or expanded for the oil mist detector for atmospheric oil mist detectors.

A.2 Principles for calibration of master detector and functional test

Calibration of the master detector should be carried out by this test procedure. Oil mist generation is to satisfy the following requirements. This procedure is also used for a functional test of the product detector.

1) Oil mist is to be generated with suitable equipment using an SAE 80 mono-grade mineral oil or equivalent, such as SAE 30 or SAE 40, and supplied to a test chamber having a volume of not less than 100 l. The oil mist produced is to have a maximum droplet size of 5 µm.

2) The oil droplet size is to be checked using the sedimentation method.

3) The oil mist concentrations used are to be ascertained by the gravimetric deterministic method or equivalent. For this test, the gravimetric deterministic method is a process where the difference in weight of a 0,8 µm pore size membrane filter is ascertained from weighing the filter before and after drawing 1 l of oil mist through the filter from the oil mist test chamber. The oil mist chamber is to be fitted with a re-circulating fan.

4) Samples of oil mist are to be taken at regular intervals and the results plotted against the oil mist detector output. The oil mist detector is to be located adjacent to where the oil mist samples are drawn off.

5) The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 % below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.

6) The filters shall be weighed to a precision of 0,1 mg and the volume of air/oil mist sampled to 10 ml.

7) Oil mist detection equipment is to be tested in the orientation (vertical, horizontal or inclined) in which it is intended to be installed on ships as specified by the equipment manufacturer.

8) Type testing is to be carried out for each type of oil mist detection and alarm equipment for which a manufacturer seeks classification approval. Where sensitivity levels can be adjusted, testing is to be carried out at the extreme and mid-point level settings.

A.3 Safety warning

All persons concerned with managing and carrying out this test shall be made aware that oil mist used for this test can be hazardous and that there is a possibility that toxic and/or harmful smoke and gases will be evolved and explosion of oil mist will occur during the test. Operational hazards can also arise during the testing of specimens and the disposal of test residues.

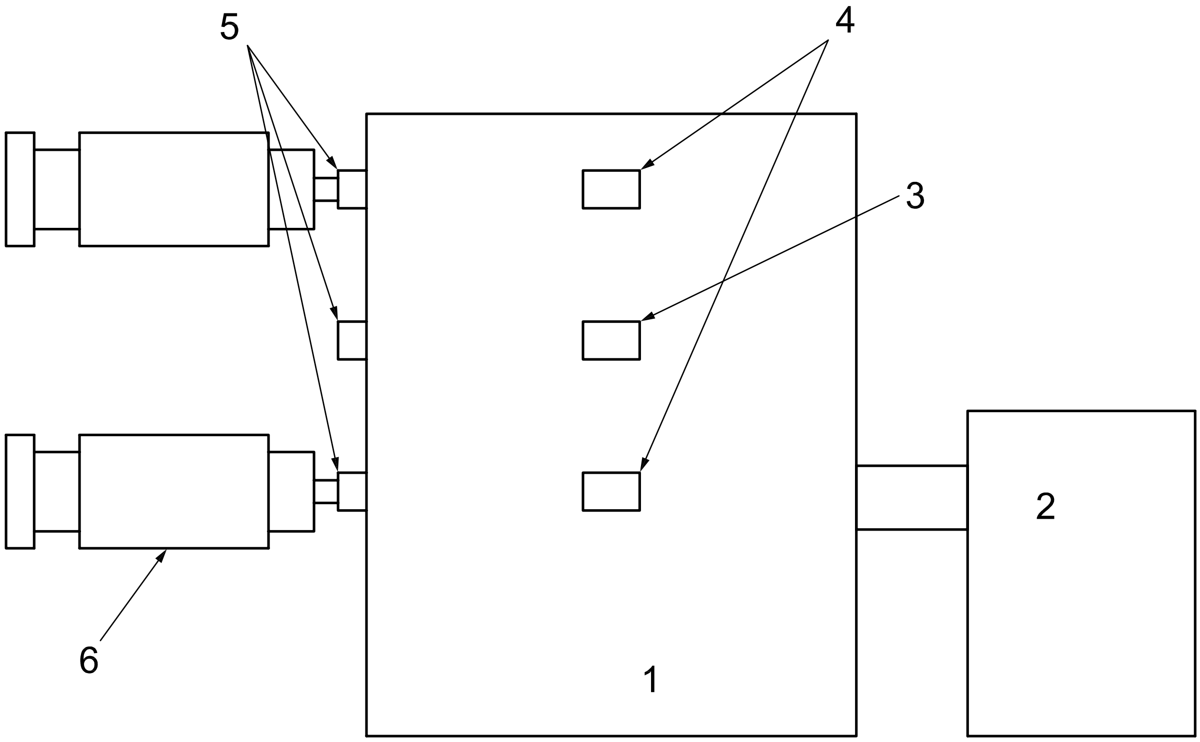
An assessment of all potential hazards and risks to health shall be made and safety precautions shall be identified and provided. Written safety instructions shall be issued. Appropriate training shall be given to relevant personnel. Laboratory personnel shall ensure that they follow written safety instructions at all times.

A.4 Test device

The oil mist detection/monitoring system consists of the oil mist detector and monitoring/alarm devices. Testing of the oil mist detector is to be carried out with the monitoring/alarm devices.

A.5 Oil mist test and calibration chamber

A diagram of the oil mist test and calibration chamber is shown in Figure A.1.



Key

1 oil mist chamber
2 oil mist generator
3 specimen oil mist detector
4 master detector
5 sampling port
6 sampling cylinder with: membrane filter (0,8 µm); control and measuring equipment; and purging and circulating fan

Figure A.1 — Oil mist test and calibration chamber

Calibration of the master detector and/or functional test for the product detector shall follow these steps.

1) The test system consists of an oil mist test chamber, an oil mist generator which has a heating unit and lubricant oil tray, sampling ports, sampling cylinders with 0,8 µm membrane filters and two master detectors.

2) Suitable control equipment for concentrates of the oil mist with purging and re-circulating fans is to be installed in the test chamber.

3) Measuring/monitoring equipment for the output signal from the specimen detector is to be arranged.

4) At least three sampling ports are to be prepared at the side wall of the test chamber.

5) The oil mist test chamber is made of clear acrylic resin material, or shall have at least one clear window for observation at the side wall.

6) Heater and temperature measuring systems are to be attached to the test chamber for control of the temperature of the oil mist chamber, if necessary.

7) The oil mist test chamber is to be scaled to the size of the specimen oil mist detector; however, it shall have a volume of not less than 200 l.

NOTE The volume of the oil mist test chamber required in IACS UR M67 [2] is not less than 1 m^3; but for safety reasons, using a test chamber with a smaller volume is recommended.

A.6 Master detector

A.6.1 Master detectors are to be calibrated by the actual oil mist condition. For this test, two sets of master detectors are to be prepared for measuring of the specimen detector. Each master detector must be suitably capable of meeting the performance characteristics and be suitable for measuring the specimen detector.

A.6.2 The oil mist concentrations used are to be ascertained by the gravimetric deterministic method or equivalent. For this test, the gravimetric deterministic method is a process where the difference in weight of a 0,8 µm pore size membrane filter is ascertained from weighing the filter before and after drawing 1 l of oil mist through the filter from the oil mist test chamber. The oil mist chamber is to be fitted with a re-circulating fan.

A.7 Oil mist generator

Oil mist is to be generated by heating an SAE 80 mono-grade mineral oil or equivalent, such as SAE 30 or SAE 40, in the oil tray of the hot plate.

An example of an oil mist generator using a heating plate is referenced in Annex C.

A.8 Sampling cylinder and membrane filter

Concentrates of the oil mist at the sampling port of the test chamber are absorbed by sampling cylinders with 0,8 µm membrane filters.

The oil mist concentration is to be ascertained by the gravimetric deterministic method whereby the weight of a membrane filter is ascertained from weighing the filter before and after drawing oil mist through the filter.

The volume of the sampling cylinder shall be not less than 1 l. To avoid the influence/dilution of the concentrates of the oil mist in the test chamber, the sampling volume is to be not more than 1 % of the oil mist test chamber.

Conditioning of membrane filter: Before the test, each 0,8 µm membrane filter that is to be used for measuring the concentration of the oil mist should be conditioned for more than 24 h to achieve a consistent moisture content, at a temperature of (23 ± 2) °C, and a relative humidity of (50 ± 10) %, and should be kept in this condition until just before the measuring or sampling.

A.9 Calibration procedure

At least two sets of monitoring or reference detectors shall be prepared, one to be fitted to the top sampling port and other to be fitted to the bottom sampling port of the test chamber shown in Figure A.1. The reference detectors are to be used for the continuous monitoring of the oil mist concentrate.

Two sets of detectors must be prepared, and they are to be calibrated with the master detector for measuring the product detector. The calibration of a master detector is to be carried out by the procedures in A.9.2.

A.9.1 Confirm the oil mist condition

Before the calibration of the master detector, it is necessary to confirm that the oil mist concentration in the test chamber and calibration system can be controlled constantly and continuously. This should be confirmed in accordance with the following process.

1) Reference detectors are to be fitted to the top and bottom of the sampling port of the test chamber.

2) Generate oil mist and introduce it to the oil mist test chamber until a stable, constant oil mist concentration of approximately 0,5 mg/l is achieved. Run the fan(s) in the test chamber to uniformly mix air and oil mist. Stabilization of the oil mist test chamber is to be monitored by the reference detector.

3) The measuring of oil mist concentration at the upper and lower port of the test chamber is to be ascertained by the gravimetric deterministic method or equivalent as prescribed in A.6.2. The membrane filter used for sampling is to be kept in the constant moisture and temperature condition until just before the sampling.

4) If the upper and lower port concentrations are within 10 % of their average, the oil mist condition in the test chamber is considered stable.

A.9.2 Calibration of master detector

Oil mist concentration in the test chamber should be controlled at the stable condition and it should be continuously monitored by the reference detectors. Calibration of the master detector is to be carried out by the following process.

1) The master detector to be calibrated is fitted to the centre sampling port of the test chamber, or it is to be located adjacent to where the oil mist samples are drawn off.

2) Generate oil mist and introduce it to the oil mist test chamber until a stable, constant oil mist concentration of approximately 0,5 mg/l is achieved. Run the fan(s) in the test chamber to uniformly mix air and oil mist. Stabilization of the oil mist test chamber is to be monitored by the reference detector.

3) Concentrates of the oil mist at the centre port of the test chamber are to be measured by sampling cylinders with a 0,8 µm membrane filter. Sample the oil mist with this sampling cylinder, and determine the oil mist concentration by the gravimetric deterministic method as prescribed in A.6.2.

4) Repeat steps 2) and 3) above with different oil mist concentrates, and plot the resultant calibration curve for the master detector. Samples of oil mist are to be taken at regular intervals and the results plotted against the oil mist detector output. Determine at least 10 calibration points. See Figure A.2.

NOTE The recommended calibration range is approximately 0,25 mg/l to 2,5 mg/l, but it should depend on the manufacturer's instructions.

5) The results of a gravimetric analysis are considered invalid and are to be rejected if the resultant calibration curve has an increasing gradient with respect to the oil mist detection reading. This situation occurs when insufficient time has been allowed for the oil mist to become homogeneous. Single results that are more than 10 % below the calibration curve are to be rejected. This situation occurs when the integrity of the filter unit has been compromised and not all of the oil is collected on the filter paper.

6) Second detector: Repeat steps 2) to 4) above with another master detector for calibration. Two sets of master detectors are to be prepared and calibrated for measuring the product detector.

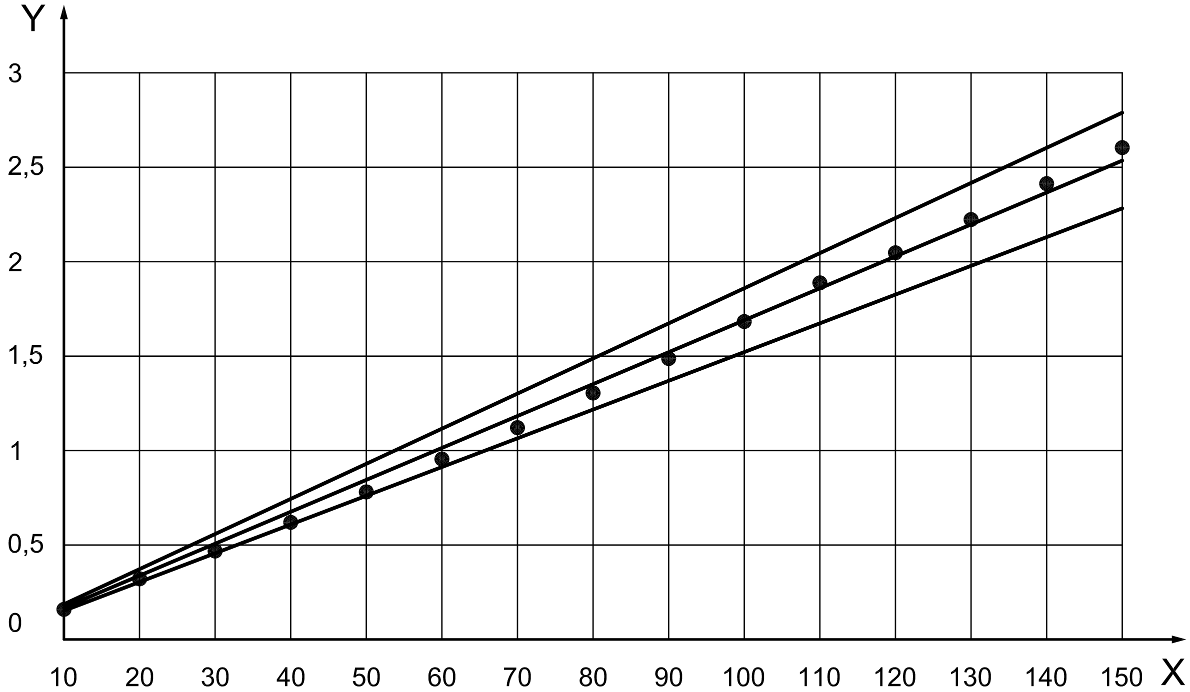
7) Master detectors are to be calibrated at least every year.

NOTE Master detectors calibrated and certified by an independent test house or laboratory recognized by the Administration may also be utilized for the test.

A.9.3 Analysis of calibration data of the master detector

Calibration data are to be plotted with the master detector output signal against the oil mist concentrate measured by the gravimetric deterministic method, as shown in Figure A.2.

The calibration equation for the master detector is determined from the slope and intercept of the straight line relationship, an example of which is shown in Figure A.2. The calibration data should not deviate more than 5 % of the actual oil mist concentrate measured by the gravimetric deterministic method at the required measuring range.



Key

X oil mist detector output signal level

Y oil mist concentrate, mg/l

Figure A.2 — Sample of calibration result of oil mist detector output signal

A.10 Test procedure for the product oil mist detector

A functional test or alarm set point measurement for product/specimen detectors and the alarm system is to be carried out with the following procedures.

1) The specimen detector is to be fitted to the centre sampling port of the test chamber shown in Figure A.1.

2) Two calibrated master detectors are to be fitted to the upper and lower ports of the test chamber shown in Figure A.1.

3) Generate oil mist, introduce it to the oil mist test chamber while keeping it slightly below the oil mist concentration of the specified alarm setting point for pre-alarm and alarm points. Run the fan(s) in the test chamber to uniformly mix air and oil mist.

4) Check if the alarm system pre-alarm and alarm points activate.

5) Incrementally increase the oil mist concentration, and check if the alarm system pre-alarm and alarm points activate.

6) Where alarm set points can be altered, the means of adjustment and indication are to be verified against the equipment manufacturer’s instructions. Record this concentration of the oil mist in the test chamber by using the master detector indicated.

7) Stabilization of the oil mist test chamber is to be monitored by the master detectors. Determine the average value of the oil mist concentrations at the upper and lower port of the test chamber. If the oil mist concentrations at the upper and lower port of the test chamber are within 10 % of the average, the oil mist condition in the test chamber is considered to be stable. If the oil mist concentrations differ more than 10 % from the average, reject this test condition, and repeat the test.

A.11 Assessment

An assessment of the oil mist detection/monitoring equipment devices after testing shall be made and shall address the following.

a) Details of the detection equipment to be tested are to be recorded including name of manufacturer, type designation, oil mist concentration assessment capability and alarm settings.

b) After completing the tests, the detection equipment is to be examined and the condition of all components ascertained and documented. Photographic records of the monitoring equipment’s condition are to be taken and included in the report.

Annex B
(informative)

Example of an alternative test method for the product detectors

B.1 Scope

This annex provides an example test apparatus and test procedures for the functional test of the oil mist detector.

For reasons of safety, efficiency and product auditing, this test is to be carried out using an alternative aerosol, smoke or certified optical filters instead of oil mist for the product measuring detector.

B.2 Principles of functional test for product detector

The detectors and alarm equipment selected for the type testing are to be selected from the manufacturer's normal production line.

All tests to verify the functionality of oil mist detection and alarm equipment are to be carried out with an oil mist concentration in air, known in terms of milligrams per litre to an accuracy of ± 10 %. The concentration of test aerosol or oil mist in the test chamber and these concentrations are not to differ by more than 10 %.

The oil mist monitoring arrangements are to be capable of detecting oil mist in air concentrations of between 0 and 10 % of the lower explosive limit (LEL) or between 0 and a percentage corresponding to a level not less than twice the maximum oil mist concentration alarm set point.

NOTE The LEL corresponds to an oil mist concentration of approximately 50 mg/l (~4,1 % weight of oil in air mixture).

The alarm set point for oil mist concentration in air is to provide an alarm at a maximum level corresponding to not more than 5 % of the LEL or approximately 2,5 mg/l. Alarm set points are dependent on the product and the manufacturer's instruction manual. A set point of 4 % of the LEL or approximately 2,0 mg/l is recommended.

Where alarm set points can be altered, the means of adjustment and indication of set points are to be verified against the equipment manufacturer's instructions.

Where oil mist is drawn into a detector via piping arrangements (aspirating detectors), the time delay between the sample leaving the protected area and operation of the alarm is to be determined for the longest and shortest lengths of pipes recommended by the manufacturer. The pipe arrangements are to be in accordance with the manufacturer's instructions/recommendations.

B.3 Test device

The oil mist detection/monitoring system consists of the oil mist detector and monitoring/alarm devices. Although this test procedure is for testing the oil mist detector, it is to be carried out with the monitoring/alarm devices.

B.4 Master detector

For this test, two sets of master detectors shall be prepared. Master detectors shall be calibrated by either of the following methods.

1) Master detectors are calibrated by the actual oil mist condition described in Annex A and Annex C.

2) Master detectors are calibrated and certified by a recognized test house or laboratory that is independent of the manufacturer.

B.5 Oil mist generator

Oil mist can be generated by using a heating plate system. An example of such an oil mist generator system is described in Annex C.

For safety reasons, commercial oil mist generators or smoke generators may be used as an alternative aerosol for the test instead of the actual lubricant oil or mono-grade mineral oil.

The following list of alternative oil mist or smoke is to be selected for the purpose of this test.

Table B.1 — Alternative oil mist source

Source of oil mist or smoke		Description
Oil mist	Lubricant oil	SAE 80 or equivalent (SAE 30 or SAE 40) mono
Alternative oil mist	Shell ondina oil[a]	Water-white oil blended/refined mineral oil
	Paraffin oil	Mineral oil
Alternative smoke	Rosco light fog fluid[a]	Tri-ethylene glycol and propylene glycol based
	Concept smoke oil[a]	mineral oil based

[a] Shell ondina oil, Rosco light fog fluid and Concept smoke oil are examples of suitable products available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of these products.

B.6 Oil mist test chamber

A diagram of the oil mist test chamber is shown in Figure B.1.

The functional test for a product detector is to be carried out by this test method. Oil mist generation should satisfy the following requirements. (Refer to Annex A calibration for master detector and Annex C for an example oil mist generator.)

1) The test system consists of an oil mist test chamber, an oil mist generator which uses an alternative oil mist or smoke instead of a mist of lubricant oil, and two master detectors.

2) Suitable control equipment with a purging and re-circulating fan is to be installed to the test chamber. Fans are to be installed in the test chamber for circulating inside air/oil mist and controlling the concentrates of the oil mist constantly, if necessary.

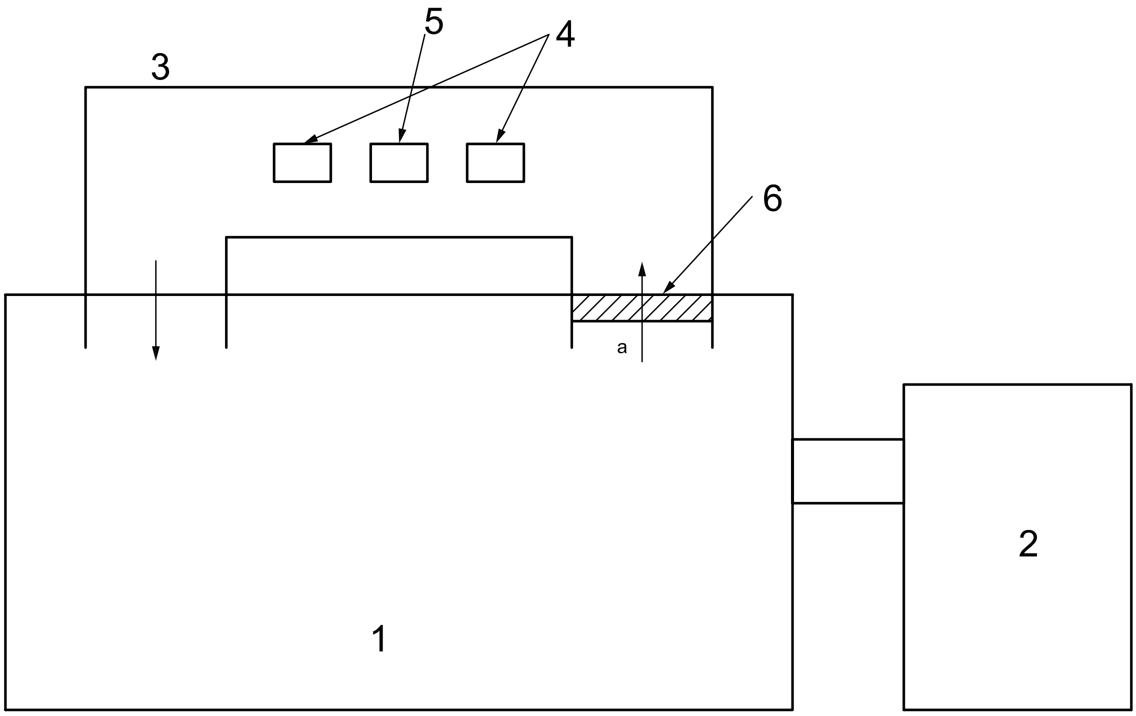
3) Measuring/monitoring equipment for the output signal from the oil mist detector is to be arranged.

4) At least three sampling ports are to be prepared at the side wall of the test chamber: two ports are for the master detector, and one port is for the product detector.

5) The oil mist test chamber should be made of clear acrylic resin material, or have sufficient clear windows at the side wall and an oil mist flow duct for observation inside of the test chamber.

6) Suitable heater and temperature measuring systems are to be attached to the test chamber for control of the temperature of the oil mist chamber, if necessary.

7) The oil mist test chamber is to be scaled to the size of the specimen oil mist detector; however, it shall have a volume of not less than 1 m^3.



Key

1 oil mist chamber

2 oil mist or smoke generator

3 oil mist flow duct

4 master detector

5 specimen oil mist detector

6 circulating fan, OMD control and measuring equipment, heater and temperature measuring equipment, and purging and circulating fan

a Oil mist flow.

Figure B.1 — Oil mist chamber, working section

B.7 Test procedure

The functional test for the product detector or specimen detector and the alarm system should follow these steps.

1) The specimen detector is to be fitted to the centre port of the oil mist flow duct shown in Figure B.1.

2) The two master detectors which were calibrated are to be attached to the upper and lower stream port of the oil mist flow duct.

3) Generate alternative oil mist or smoke; introduce it to the oil mist test chamber while keeping it slightly below the oil mist concentration of the specified alarm setting point. Run the fan(s) in the test chamber to uniformly mix air and oil mist.

4) Check if the alarm system pre-alarm and alarm points activate.

5) Incrementally increase the oil mist concentration, and check if the alarm system pre-alarm and alarm points activate.

6) Where alarm set points can be altered, the means of adjustment and indication are to be verified against the equipment manufacturer's instructions. Record this concentration of the oil mist in the test chamber by the master detector indicated.

7) Stabilization of the oil mist test chamber is to be monitored by the master detectors. Determine the average value of the oil mist concentrations at the upper and lower ports of the oil mist flow duct. If the upper and lower port concentrations are within 10 % of their average, the oil mist condition in the test

chamber is considered stable. If the oil mist concentrations differ more than 10 % from their average, reject this test condition, and repeat it.

8) All tests to verify the functionality of oil mist detection/monitoring devices are to be carried out in accordance with 1) to 7) with an oil mist concentration in air, known in terms of milligrams per litre to an accuracy of ± 10 %.

9) The oil mist monitoring arrangements are to be capable of detecting oil mist in air concentrations of between 0 and 10 % of the lower explosive limit (LEL), where the LEL corresponds to an oil mist concentration of approximately 50 mg/l (13 % oil–air mixture).

10) The operation of the alarm indicators for oil mist concentration in air are to be verified and are to provide an alarm at a maximum setting corresponding to 5 % of the LEL corresponding to approximately 2,5 mg/l.

NOTE The test chamber described in Annex A can be used for the test of product detectors instead of the test chamber shown in Figure B.1.

Annex C
(informative)

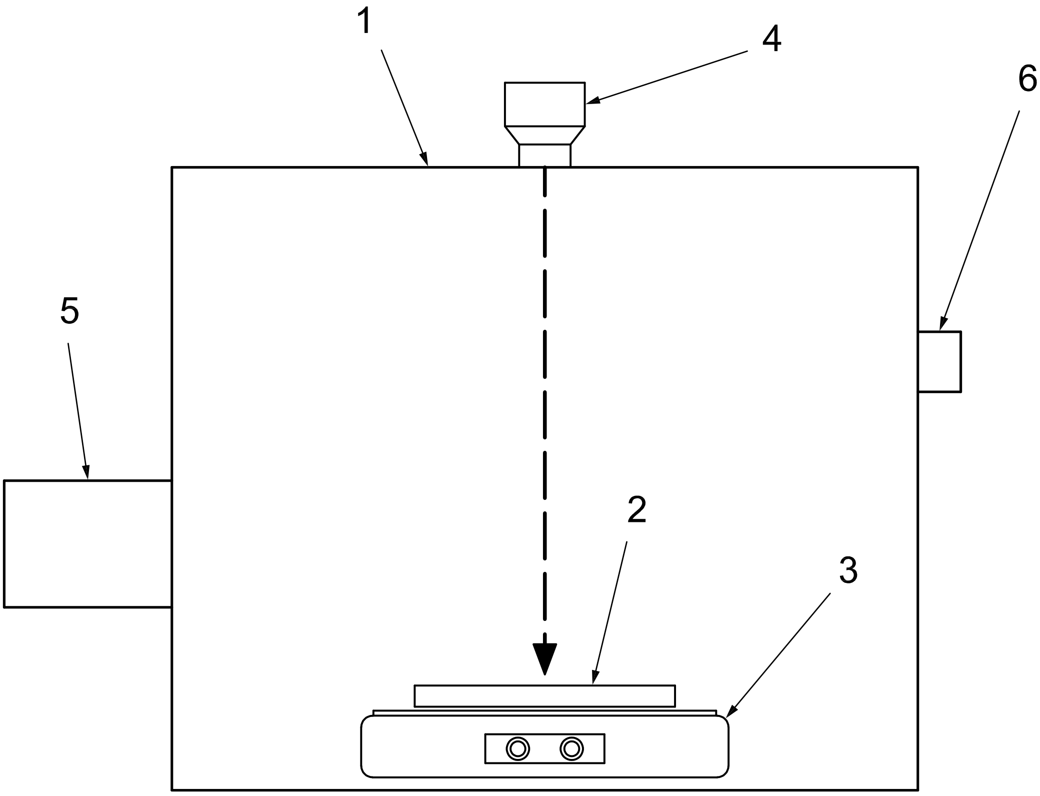
Example of an oil mist generator

C.1 Outline of oil mist generator

Oil mist is generated by heating a mineral oil or equivalent which is to be used for the calibration and functional test of the oil mist detector. A hotplate with actual lubricant oil in an oil tray and a small oil mist chamber with purging system are used for the test. This annex shows an example of an oil mist generator.

C.2 Oil mist generator and chamber

A diagram of the oil mist chamber is shown in Figure C.1.



Key

1 oil mist generator chamber

2 oil tray (100 mm – 150 mm diameter)

3 hotplate (max. temp. 350 °C – 400 °C)

4 oil supply port (oil mist drop to the oil tray)

5 purging fan (sends oil mist to the test chamber)

6 monitoring for oil mist concentration

Figure C.1 — Oil mist generator and small chamber

The oil mist generator consists of a hotplate, an oil tray, an oil mist generator chamber with oil supply port and sampling or monitoring ports, and purging fan.

The oil mist test chamber should be made of clear acrylic resin material and have a volume of at least 100 l. An oil supply port or oil supply system, which can control oil supply speed, is to be attached.

A purging fan for introducing generated oil mist to the oil mist test chamber is to be attached.

Measuring/monitoring port for concentrates of the oil mist is to be arranged, if necessary.

C.3 Fuel (oil mist source)

SAE 80 mono-grade mineral oil or equivalent is to be used.

The oil mist produced is to have a maximum droplet size of 5 μm.

IMPORTANT — The oil droplet size is to be checked using the sedimentation method. Refer to IACS UR M67 [2].

C.4 Hotplate

Oil mist is to be generated by heating an SAE 80 mono-grade mineral oil in the oil tray of the hotplate, e.g. approximately 100 ml of diesel engine lubricant oil placed in a round steel tray with a diameter of approximately 100 mm.

The hotplate (see Figure C.1) shall have a 100 mm – 150 mm diameter oil tray. The hotplate shall have a rating of approximately 1 kW and a suitable temperature control for maximum temperatures of 350 °C – 400 °C.

The tray containing the fuel shall be placed in the centre of the hotplate. The temperature of the hotplate shall be measured by an attached sensor and have good thermal contact to the oil tray. Commercial hotplates are available for this application.

C.5 Oil mist concentrate validity method

Use the gravimetric deterministic method or equivalent to determine the oil mist concentration level. The precision of measurement for the sample shall be not less than 0,1 mg for the filter and 10 ml for the air/oil volume. Use a sampling cylinder and membrane filter described in A.8 for the gravimetric deterministic method.

Annex D
(informative)

Location and installation of atmospheric detectors

D.1 Proper location and installation of oil mist detectors

Proper location and installation of oil mist detectors is crucial; otherwise a poorly located detector or poorly spaced series of detectors may defeat the purpose: to detect hazardous concentrations of oil in air. The major factors determining the number and location of oil mist detectors are the number of potential oil mist emitters (e.g. diesel engines, fuel oil purifiers, boilers) and the number and location of air exhaust vents. Oil mist detection systems are most effective when they are installed above potential emitters or, in the case of spaces with multiple emitters, between machinery and air exhaust vents.

D.2 The optimum location for a single oil mist source

The optimum location for a single oil mist source is above the potential emitter. An enclosed small plant room may only need one detector placed above the potential source being monitored. While convenient, an oil mist detector should never be placed on an adjacent bulkhead, since the earliest detection is likely to occur above the source and not at adjacent bulkheads. Oil mist will take additional time to reach detectors on the deck or bulkhead due to obstructions in the machine spaces and the dilution of the mist as shown in Figure D.1. The most likely hazardous oil mist concentrations to be seen on a vessel are not of a sufficiently large volume to be detected on adjacent decks or bulkheads; therefore placement as discussed above is crucial for the success of oil mist detection.

D.3 For machinery rooms with multiple potential sources of oil mist generation

For machinery rooms with multiple potential sources of oil mist generation, enough detectors should be strategically installed between machinery capable of generating oil mist and the air exhaust vents.

D.4 The number of detectors

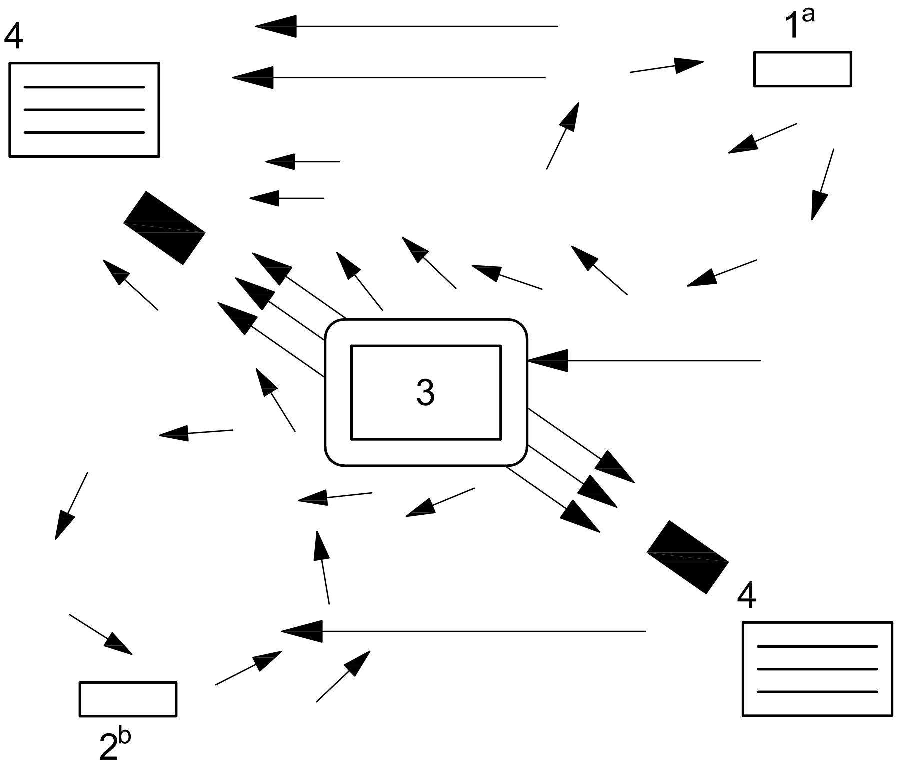
The number of detectors will depend on the number of exhaust vents. The optimal means to ensure the detectors are positioned correctly is by using a smoke generator. Smaller spaces may be evaluated using a spray can to generate oil mist.

D.5 The final placement of oil mist detectors

As the oil mist progresses toward exhaust vents, dilution is likely to occur. In order to avoid dilution of oil mist concentrations to levels below hazard identification, larger areas requiring monitoring are best evaluated with a smoke generator. Obstacles such as duct and piping and parts of the engine will deflect the mist and should be taken into account when determining the number and placement of detectors. However, in these areas the installation of detectors on decks, bulkheads or other convenient structures should be avoided even though they may be convenient locations.

The final placement of the detectors must only be determined when all potential emitters and air exhaust units are operational and running, to best determine the actual characteristics of the airflow.

In an engine room, several detectors are likely needed, but the exact location will vary according to airflow. Refer to Figure D.1.



Key

(Long arrow) direction of movement of air

(Short arrow) direction of movement of air as part of an eddy

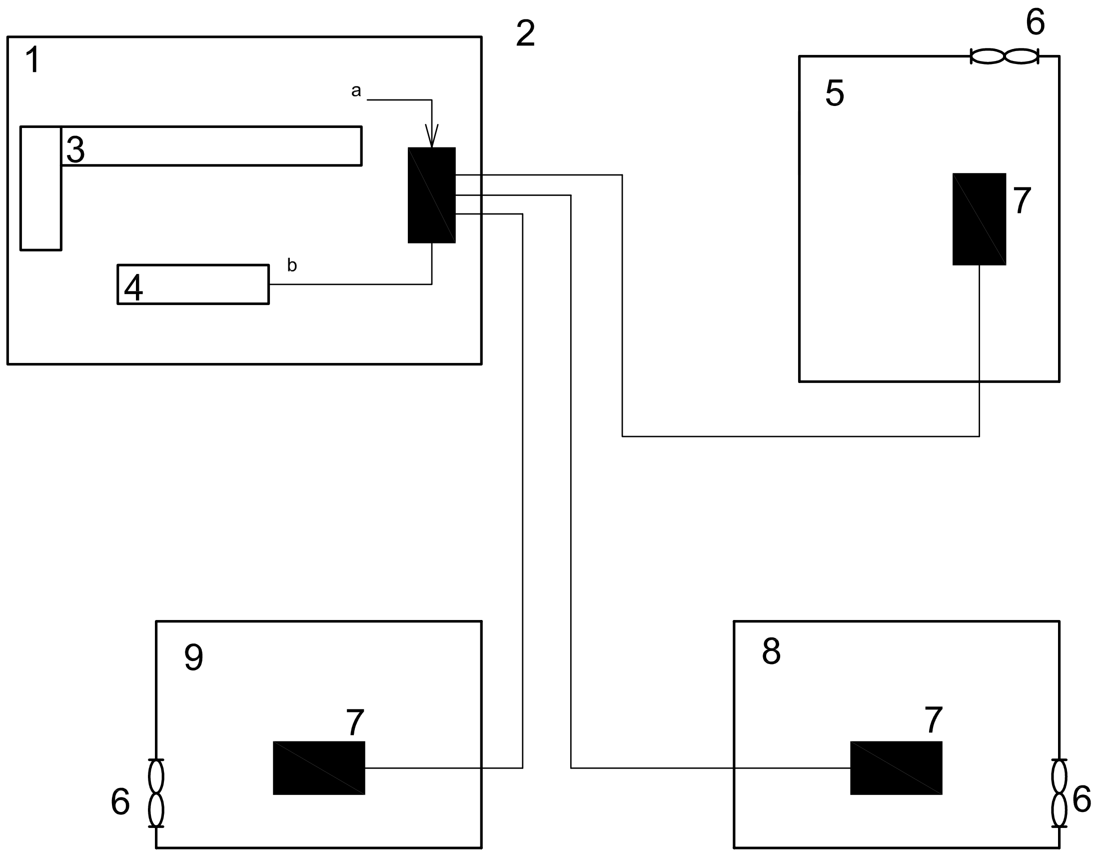
Location of an oil mist detector

1 eddy 1
2 eddy 2
3 source of oil mist
4 extractor/vent
a Eddy 1 does not require monitoring as it is upstream of the potential oil mist source.
b Location of the detector in eddy 2 is recommended as oil mist may be drawn away from the vent.

Figure D.1 — Placement of oil mist detectors relative to emitter and air exhaust vents

D.6 Wiring for installation

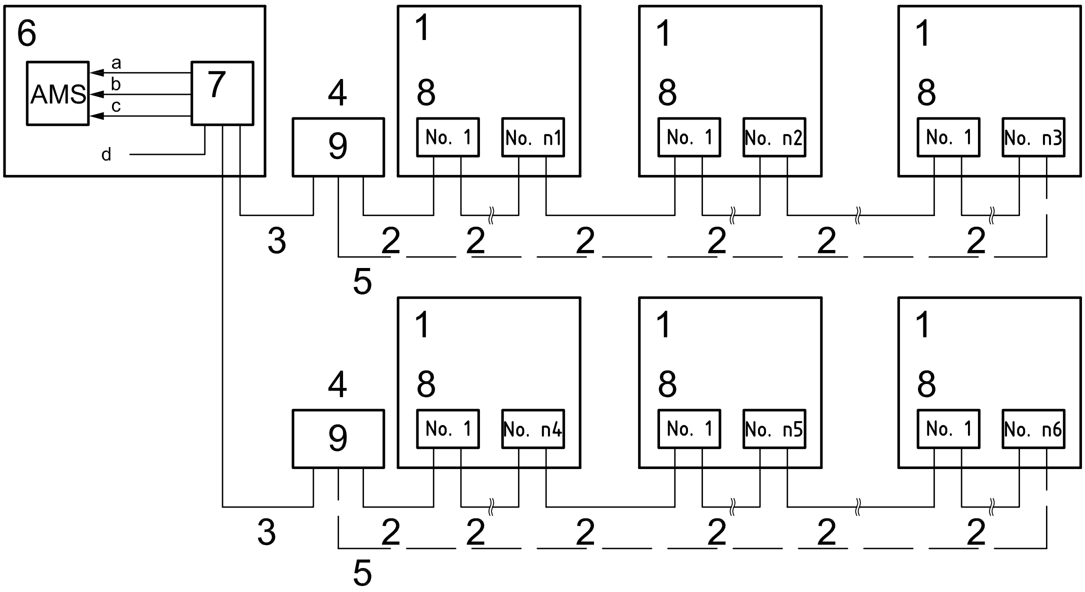
Typical wirings for installation are “star connection” and “daisy chain”. An example of star connection wiring for installation schemes is shown in Figure D.2, and an example of daisy chain wiring for installation schemes is shown in Figure D.3.



Key

1 Engine Control Room
2 oil mist monitor
3 main switchboard panel
4 alarm plant
5 Power Pack Room
6 extractor
7 oil mist detector
8 Generator Room
9 Purifier Room
a Power supply.
b To main alarm.

Figure D.2 — Example of star connection wiring for installation schemes



Key

1 main engine, generator engine, rudder unit, high hydraulic pump, etc

2 RTFRO 4 X 0.75

3 MPYCS – 4

4 wiring between monitor and sensors, either through a direct connection to monitor or through one junction box; both cases are acceptable

5 basic wiring system to be daisy chain connected; alternative loop connection can be accepted

6 Control Room

7 monitor

8 oil mist detector

9 junction box

a high alarm

b pre-alarm

c system failure

d power supply

Figure D.3 — Example of daisy chain wiring for installation schemes

Bibliography

[1] IMO Circular MSC/Circ.1086, Code of Practice for Atmospheric Oil Mist Detectors, 18 June 2003

[2] International Association of Classification Societies Unified Requirement M67, *Type Testing Procedure for Crankcase Oil Mist Detection and Alarm Equipment*

[3] ISO 7240-1, *Fire detection and alarm systems — Part 1: General and definitions*

ICS 13.220.20; 47.020.01

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